

CLAIMS

We claim:

1. A cylindrical filter of a high accuracy composed of non-woven fibrous agglomerates and comprising at least two layers of a pre-filtration layer and a precision filtration layer disposed in the direction of filtration, each of said pre-filtration layer and said precision filtration layer being formed with a non-woven fabric, in which at least a part of the fibers are bonded to each other at their contact points by heat treatment, wherein the diameter of all or part of the fibers constituting said non-woven fabric in said pre-filtration layer becomes gradually smaller toward the direction of filtration, said precision filtration layer comprising one or more layers of the non-woven fabric, and the diameter of fibers which account for 10% by weight or more of the fibers in said one or more layers of the non-woven fabric being smaller than the diameter of the fibers having a smallest diameter in said pre-filtration layer.

2. The filter of a high accuracy according to claim 1 wherein said pre-filtration layer comprises a non-woven fabric comprising at least one kind of fibers selected from the group consisting of polyolefin fibers and polyester fibers.

3. The filter of a high accuracy according to claim 1 wherein said pre-filtration layer comprises a non-woven fabric prepared by a melt-blow process.

4. The filter of a high accuracy according to claim 1 wherein the fibers in the non-woven fabric of said pre-filtration layer comprise a high melting point component and a low melting point component, the difference in melting point between said high melting point component and said low melting point component is 10°C or more, and said low melting point component is contained in an amount of 10 to 90% by weight in said pre-filtration layer.

5. The filter of a high accuracy according to claim 1 wherein the fibers of the non-woven fabric of said pre-filtration layer are composite fibers comprising a high

melting point component and a low melting point component having a difference in melting point of 10°C or more.

6. The filter of a high accuracy according to claim 1 wherein the non-woven fabric of said pre-filtration layer is a mixture of ultrafine fibers of a high melting point component and ultrafine fibers of a low melting point component having a difference in melting point of 10°C or more.

7. The filter of a high accuracy according to claim 1 wherein the ratio of a smallest diameter to a largest diameter of fibers in the non-woven fabric of said pre-filtration layer is 1:2 to 1:10.

8. The filter of a high accuracy according to claim 1 wherein the ratio of the diameter of fibers in the non-woven fabric of said precision filtration layer, which comprises fibers having a diameter smaller than that of fibers having a smallest diameter in said pre-filtration layer, to a smallest diameter of the fibers in said pre-filtration layer is 1:1.1 to 1:20.

9. The filter of a high accuracy according to claim 1 wherein the non-woven fabric of said precision filtration layer, which comprises fibers having a diameter smaller than that of the fibers having a smallest diameter in said pre-filtration layer, has a void ratio of 45 to 97%.

10. The filter of a high accuracy according to claim 1 wherein the non-woven fabric of said precision filtration layer, which comprises fibers having a diameter smaller than that of the fibers having a smallest diameter in said pre-filtration layer, is prepared by a melt-blow process.

11. The filter of a high accuracy according to claim 1 wherein the non-woven fabric of said precision filtration layer, which comprises fibers having a diameter smaller than that of the fibers having a smallest diameter in said pre-filtration layer, comprises glass fibers.

12. The filter of a high accuracy according to claim 1 wherein said precision filtration layer comprises a non-woven fabric other than the non-woven fabric in said pre-filtration layer.

13. The filter of a high accuracy according to claim 1 wherein said precision filtration layer comprises a non-woven fabric prepared by a process separate from that used for the preparation of the non-woven fabric in said pre-filtration layer.

14. The filter of a high accuracy according to claim 1 wherein a void ratio (%) of said pre-filtration layer is 55 to 90%, and the value obtained by subtracting a void ratio (%) of said precision filtration layer from the void ratio (%) of said pre-filtration layer is in the range between 5% and 45%.

15. The filter of a high accuracy according to claim 12 wherein a void ratio of said pre-filtration layer is 55 to 90%, and the value obtained by subtracting a void ratio (%) of said precision filtration layer from the void ratio (%) of said pre-filtration layer is in the range between 5% and 45%.

16. The filter of a high accuracy according to claim 13 wherein a void ratio of said pre-filtration layer is 55% to 90%, and the value obtained by subtracting a void ratio (%) of said precision filtration layer from the void ratio (%) of said pre-filtration layer is in the range between 5% and 45%.

17. The filter of a high accuracy according to claim 13 wherein said pre-filtration layer comprises a non-woven fabric comprising at least one kind of fiber selected from the group consisting of polyolefin fibers and polyester fibers.

18. The filter of a high accuracy according to claim 12 wherein said pre-filtration layer comprises a non-woven fabric comprising at least one kind of fiber selected from the group consisting of polyolefin fibers and polyester fibers.

19. The filter of a high accuracy according to claim 12 wherein said pre-filtration layer comprises a non-woven fabric prepared by a melt-blow process.

20. The filter of a high accuracy according to claim 13 wherein said pre-filtration layer comprises a non-woven fabric prepared by a melt-blow process.

21. The filter of a high accuracy according to claim 12 wherein the fibers in the non-woven fabric of said pre-filtration layer comprise a high melting point component and a low melting point component, the difference in melting point between said high melting point component and said low melting point component is 10°C or more, and said low melting point is contained in an amount of 10 to 90% by weight in said pre-filtration layer.

22. The filter of a high accuracy according to claim 13 wherein the fibers in the non-woven fabric of said pre-filtration layer comprise a high melting point component and a low melting point component, the difference in melting point between said high melting point component and said low melting point component is 10°C or more, and said low melting point component is contained in an amount of 10 to 90% by weight in said pre-filtration layer.

23. The filter of a high accuracy according to claim 12 wherein the fibers of the non-woven fabric of said pre-filtration layer are composite fibers comprising a high melting point component and a low melting point component having a difference in melting point of 10°C or more.

24. The filter of a high accuracy according to claim 13 wherein the fibers of the non-woven fabric of said pre-filtration layer are composite fibers comprising a high melting point component and a low melting point component having a difference in melting point of 10°C or more.

25. The filter of a high accuracy according to claim 12 wherein the non-woven fabric of said pre-filtration layer is a mixture of ultrafine fibers of a high

melting point component and ultrafine fibers of a low melting point component having a difference in melting point of 10°C or more.

26. The filter of a high accuracy according to claim 13 wherein the non-woven fabric of said pre-filtration layer is a mixture of ultrafine fibers of a high melting point component and ultrafine fibers of a low melting point component having a difference in melting point of 10°C or more.

27. The filter of a high accuracy according to claim 12 wherein the ratio of a smallest diameter to a largest diameter of fibers in the non-woven fabric of said pre-filtration layer is 1:2 to 1:10.

28. The filter of a high accuracy according to claim 13 wherein the ratio of a smallest diameter to a largest diameter of fibers in the non-woven fabric of said pre-filtration layer is 1:2 to 1:10.

29. The filter of a high accuracy according to claim 12 wherein the ratio of the diameter of fibers in the non-woven fabric of said precision filtration layer, which comprises fibers having a diameter smaller than that of fibers having a smallest diameter in said pre-filtration layer, to a smallest diameter of the fibers in said pre-filtration layer is 1:1 to 1:20.

30. The filter of a high accuracy according to claim 13 wherein the ratio of the diameter of fibers in the non-woven fabric of said precision filtration layer, which comprises fibers having a diameter smaller than that of fibers having smallest diameter in said pre-filtration layer, to a smallest diameter of the fibers in said pre-filtration layer is 1:1 to 1:20.

31. The filter of a high accuracy according to claim 12 wherein the non-woven fabric of said precision filtration layer, which comprises fibers having a diameter smaller than that of the fibers having smallest diameter in said pre-filtration layer, has a void ratio of 45 to 97%.

32. The filter of a high accuracy according to claim 13 wherein the non-woven fabric of said precision filtration layer, which comprises fibers having a diameter smaller than that of fibers having a smallest diameter in said pre-filtration layer, has a void ratio of 45 to 97%.

33. The filter of a high accuracy according to claim 12 wherein the non-woven fabric of said precision filtration layer, which comprises fibers having a diameter smaller than that of the fibers having a smallest diameter in said pre-filtration layer, is prepared by a melt-blow process.

34. The filter of a high accuracy according to claim 13 wherein the non-woven fabric of said precision filtration layer, which comprises fibers having a diameter smaller than that of the fibers having a smallest diameter in said pre-filtration layer, is prepared by a melt-blow process.

35. The filter of a high accuracy according to claim 12 wherein the non-woven fabric of said precision filtration layer, which comprises fibers having a diameter smaller than that of the fibers having a smaller diameter in said pre-filtration layer, comprises glass fibers.

36. The filter of a high accuracy according to claim 13 wherein the non-woven fabric of said precision filtration layer, which comprises fibers having a diameter smaller than that of the fibers having a smaller diameter in said pre-filtration layer, comprises glass fibers.

37. The filter of a high accuracy according to claim 1 wherein said filter further comprises a support layer, said support layer being formed with a non-woven fibrous agglomerate, the diameter of the fibers constituting said non-woven fibrous agglomerate in said support layer is larger than the diameter of the fibers in said precision filtration layer, and at least a part of the fibers constituting said non-woven fibrous agglomerate in said support layer being bonded each other by heat treatment.

38. A cylindrical filter of a high accuracy composed of non-woven fibrous agglomerates and comprising at least three layers of a pre-filtration layer, a precision filtration layer, and a support layer disposed in the direction of filtration, said pre-filtration layer being formed with a non-woven fibrous agglomerate prepared by a melt-blow process, and the diameter of all or part of the fibers constituting said non-woven fibrous agglomerate in said pre-filtration layer becomes gradually smaller toward the direction of filtration, said precision filtration layer comprising one or more layers of a non-woven fibrous agglomerate, and the diameter of fibers which account for 10% by weight or more of the fibers in said one or more layers of the non-woven fibrous agglomerate being smaller than the diameter of the fibers having a smallest diameter in said pre-filtration layer, and said support layer being formed with a non-woven fibrous agglomerate in which at least a part of the fibers are bonded by heat treatment, and the diameter of the fibers constituting said non-woven fibrous agglomerate in said support layer is larger than the diameter of the fibers in said precision filtration layer.

39. The filter of a high accuracy according to claim 38 wherein said pre-filtration layer comprises a non-woven fibrous agglomerate comprising at least one kind of fibers selected from the group consisting of polyolefin fibers and polyester fibers.

40. The filter of a high accuracy according to claim 38 wherein the fibers of the non-woven fibrous agglomerate of said pre-filtration layer are composite fibers comprising a high melting point component and a low melting point component having a difference in melting point of 10°C or more, said low melting point component forming at least a part of the surface of the composite fibers.

41. The filter of a high accuracy according to claim 38 wherein the non-woven fibrous agglomerate of said pre-filtration layer is a mixture of ultrafine fibers of a high melting point component and ultrafine fibers of a low melting point component having a difference in melting point of 10°C or more.

42. The filter of a high accuracy according to claim 38 wherein the ration of a smallest diameter to a largest diameter of fibers in the non-woven fibrous agglomerate of said pre-filtration layer is 1:2 to 1:10.

43. The filter of a high accuracy according to claim 38 wherein the ratio of the diameter of fibers in the non-woven fibrous agglomerate of said precision filtration layer, which comprises fibers having a diameter smaller than that of fibers having a smallest diameter in said pre-filtration layer, to a smallest diameter of the fibers in said pre-filtration layer is 1:1 to 1:20.

44. The filter of a high accuracy according to claim 38 wherein the non-woven fibrous agglomerate of said precision filtration layer, which comprises fibers having a diameter smaller than that of the fibers having a smallest diameter in said pre-filtration layer, has a void ratio or 45 to 97%.

45. The filter of a high accuracy according to claim 38 wherein the non-woven fibrous agglomerate of said precision filtration layer, which comprises fibers having a diameter smaller than the of the fibers having a smallest diameter in said pre-filtration layer, is prepared by a melt-blow process.

46. The filter of a high accuracy according to claim 38 wherein the non-woven fibrous agglomerate of said precision filtration layer, which comprises fibers of a diameter smaller than that of the fibers having a smallest diameter in said pre-filtration layer, comprises glass fibers.

47. The filter of a high accuracy according to claim 38 wherein said precision filtration layer comprises a non-woven fibrous agglomerate prepared by a process separate from that used for the preparation of the non-woven fibrous agglomerate in said pre-filtration layer.

48. The filter of a high accuracy according to claim 38 wherein a void ratio of said pre-filtration layer is 55 to 90%, and the value obtained by subtracting a void



ratio (%) of said precision filtration layer from the void ratio (%) of said pre-filtration layer is in the range of 5% and 45%.

49. The filter of a high accuracy according to claim 38 wherein said precision filtration layer comprises a non-woven fibrous agglomerate comprising at least one kind of fibers selected from the group consisting of polyolefin fibers and polyester fibers.

50. The filter of a high accuracy according to claim 38 wherein the diameter of all or part of the fibers constituting said non-woven fibrous agglomerate in said support layer becomes gradually larger toward the direction of filtration.

51. The filter of a high accuracy according to claim 38 wherein the diameter of all or part of the fibers constituting said non-woven fibrous agglomerate in said support layer first becomes gradually smaller and then become gradually larger toward the direction of filtration.

52. The filter of a high accuracy according to claim 38 wherein approximate thickness of said pre-filtration layer, precision filtration layer, and support layer is about 49 to 90%, 4%, and 6 to 48%, respectively, based on the total thickness of filter.

53. The filter of a high accuracy according to claim 38 wherein each of said pre-filtration layer and said precision filtration layer is formed with a non-woven fabric, in which at least a part of fibers are bonded each other by heat treatment.

54. The filter of a high accuracy according to claim 38 wherein each of said pre-filtration layer, said precision filtration layer, and said support layer is formed with a non-woven fabric, in which at least a part of fibers are bonded each other by heat treatment.